Performance of New Forage Varieties for Grazing

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Abstract

Saskatchewan beef producers require forage varieties that are high yielding, of good nutritional quality and persist in western Canada. New forage varieties require evaluation under grazed conditions to determine suitability for grazing purposes. A grazing trial near Lanigan, Saskatchewan evaluated crested wheatgrass (CWG) (*Agropyron cristatum* (L.) Gaertn.) cv. 'Goliath', meadow bromegrass (MBG) (*Bromus riparius* Rehm.) cv. 'Paddock', smooth bromegrass (SBG) (*B. inermis* Leyss) cv. 'Carlton', hybrid bromegrass (HBG) (*B. riparius* Rehm. X *B. inermis* Leyss) cv. 'AC Knowles' and tall fescue (TF) (*Festuca arundinacea* Schreb.) cv. 'Courtney' compared to an old established stand of CWG (*A. cristatum*) for cumulative dry matter yield (CDMY), average daily gain (ADG) of yearling steers, animal grazing days (AGD) and total beef production per hectare (TBP). There was no significant species x year interaction for ADG, AGD and TBP and data was analyzed using the mean of 2004 and 2005. In 2005, CWG cv. 'Goliath' yielded significantly higher ($p<0.05$) than all other varieties. The long established CWG showed higher ADG than HBG established in 2003 ($p<0.05$) but was not significantly different than the other varieties. The long established stand of CWG had the lowest AGD, while TF, MBG and HBG had the greatest animal grazing days ($p<0.05$). Tall fescue, MBG, HBG, SBG and CWG cv. 'Goliath' yielded higher TBP than the long established stand of crested wheatgrass ($p<0.05$). New forage varieties have the potential to perform better than long established stands of crested wheatgrass.

Introduction

On many Saskatchewan farms, beef cow-calf producers traditionally feed their cattle in confinement from October to April and utilize their pastures for only four to five months of the year. Extending the summer grazing period can reduce the use of stored feed and decrease the cost of over-wintering cattle. Highmoor (2005) reported the cost of over-wintering a cow to be $1.78/cow/winter feeding day and the cost for summer pasture to be less than $0.80/cow/day. Providing new grazing data for perennial pastures is needed to extend the grazing season.

Beef producers require forage varieties that are high-yielding, of good nutritional quality and have relatively long persistence under grazed conditions. Forage varieties have been developed and evaluated in small plot trials using mechanical methods of defoliation, such as mowing or

clipping. Mechanical treatments fail to impose grazing animal effects, such as pulling, treading, manure and urine deposition and short stubble heights, which may cause different responses than frequent clipping (McCartney and Bittman 1994). Few grass forage species have been evaluated for livestock performance and stand persistence under grazed conditions before being commercially released.

Historically, crested wheatgrass (CWG) (*Agropyron cristatum* (L.) Gaertn.) and smooth bromegrass (SBG) (*Bromus inermis* Leyss) have been used as both a hay and pasture species in western Canada. The high quality, early spring growth of CWG makes it suitable for use in complementary grazing systems. However, as this species matures, quality declines very quickly (Hart et al. 1983a) and it is often unpalatable to livestock. Crested wheatgrass is very drought tolerant, winter hardy and tends to persist for long periods of time. Smooth bromegrass is an up-right growing, rhizomatous perennial grass that forms a dense sod. A native to western Europe, this species is extremely winter hardy and is drought and heat tolerant. Since its introduction to North America in the 1880's, SBG has been widely used as both a hay and pasture species, but its slow regrowth makes it more suited to hay production (Smith et al. 1986).

More recently, meadow bromegrass (MBG) (*B. riparius* Rehm.), hybrid bromegrass (HBG) (*B. riparius* Rehm. X *B. inermis* Leyss) and tall fescue (TF) (*Festuca arundinacea* Schreb.) have been examined for their pasture potential. Meadow bromegrass, a bunch-type grass, shows increased regrowth compared to SBG, and the basal nature of the leaves makes this species more suitable for pasture rather than hay production. This species is often used in mixtures with alfalfa and other legumes and there is little published data on forage and livestock performance in pure stands (Knowles et al. 1993). Breeding programs initiated at the Saskatoon Research Centre of Agriculture and Agri-food Canada generated HBG, which is a cross between SBG and meadow bromegrass. This species was selected to have characteristics that are intermediate to the two parental lines (Coulman 2004) and has been shown to be suitable for hay and pasture production (Knowles and Baron 1990). Tall fescue is a deep-rooted, bunch-type grass which is less winter-hardy than smooth bromegrass. Its forage quality persists into the fall and it has been demonstrated to provide excellent fall and winter grazing forage (Smith et al. 1986). This species is generally adapted to humid, termperate areas of the world, and its stand persistence in the western Canada climate is unknown.

This grazing trial evaluated a number of grass varieties under grazed conditions for cumulative dry matter yield (CDMY), average daily gain (ADG), animal grazing days (AGD) and total beef production (TBP).

Materials and Methods

Pasture and Animal Management

In 2004 and 2005, a grazing trial was conducted on an 11.2 ha pasture located near Lanigan, Saskatchewan at the Western Beef Development Centre's Termuende Research Farm. Two, 0.8 ha replicates each of MBG cv. 'Paddock', SBG cv. 'Carlton' and HBG cv. 'AC Knowles' were established in 1999. Two, 0.8 ha replicates each of CWG cv. 'Goliath', TF cv. 'Courtney' and HBG cv. 'AC Knowles' were established in 2003. With the exception of TF, all paddocks were

grazed in 2004 and forage and animal production data were collected. Also, acting as a control pasture, a long established stand of CWG (unknown cultivar) was grazed in 2005. The topography at the site is gently to moderately hummocky and the soils are mixed orthic black and carbonated Oxbow, with a loam texture.

Prior to grazing, all paddocks were fertilized with nitrogen (78 kg ha^{-1}) and phosphorus (23 kg ha^{-1}) in the spring of 2004 and 2005 via coulter disc application according to soil test recommendations.

Available forage (kg DM ha^{-1}) was measured at start of test by clipping three 0.25 m^2 quadrats to a stubble height of 2.5 centimeters. Cumulative dry matter yield was then determined throughout the trial using the cage comparison technique ('t Mannetje 1978). Each paddock had three randomly placed grazing exclusion cages allocated prior to grazing. On sampling days, available forage was determined by clipping one 0.25 m^2 quadrat inside and one quadrat outside each cage. After clipping, cages were randomly repositioned within the paddock. Previously harvested areas were not re-harvested in the following sampling periods as cages were moved after each weekly sampling. Cumulative dry matter yield was determined for each paddock using the following formula:

> CDMY = initial growth + (Week 1 inside cage clip – initial growth) + (Week 2 inside cage clip – Week 1 outside cage clip) + (Week 3 inside cage clip – Week 2 outside cage clip) + … (Thompson 2003).

Dry matter yield was determined by oven drying all samples in forced draught oven at 55 °C for 48 hours and weighing the remaining forage material.

Grazing commenced when available forage was approximately 20 cm high (4-5 leaf stage). Crested wheatgrass paddocks were grazed in May due to the growth characteristics and early maturity of the species. The mid-season species were grazed June through July. Individual paddocks were fenced with electric fencing and water was provided to all paddocks in stock troughs through surface pipelines. Steers had ad libitum access to cobalt iodized salt and a 1:1 range mineral. Prior to the start of trial, steers were allowed to graze a common pasture.

Steers were weighed on two consecutive days at the start and end of trial and every seven days throughout the course of the trial. Initial steer weights averaged 313 ± 29 kg and 338 ± 16 kg in 2004 and 2005, respectively. Steer production was evaluated using a "put and take" grazing system with three randomly chosen tester steers per paddock (Mott and Lucas 1952). "Put and take" steers were added or removed from paddocks to maintain similar forage availability in each pasture type. Steers remained on each pasture until plants were grazed to a uniform level of approximately 8 centimeters. Average daily weight gain was determined using the start and end of trial weights of the three tester steers in each paddock. Animal grazing days (on a per hectare basis) was determined using both tester and 'put and take' animals. Animal grazing days was calculated as (Σ(AUE x days on pasture))/pasture area. Total beef production was calculated for each pasture as ADG of the tester steers*AGD and expressed on a per hectare basis (Mott and Lucas 1952).

The experiment consisted of a completely randomized design with the seven grass varieties as treatments, with two pasture replicates. Treatment effects were analyzed using the SAS General

Linear Model procedure for analysis of variance (SAS 1999). When significant differences were indicated ($p<0.05$), means were separated at the 5% level of significance using the Duncan's test (Steel et al. 1997).

Results and Discussion

Monthly rainfall and mean monthly temperatures during the grazing period (April to July) are shown in Table 1. Grazing period dates for the 2004 and 2005 season are reported in Table 2.

Table 1. Precipitation (mm) and Mean Monthly Temperature (°C) Between April and July for 2004 and 2005 at Lanigan, Saskatchewan.

Month	2004		2005	
	Precipitation (mm)	Temperature (°C)	Precipitation (mm)	Temperature (°C)
April	6.7	3.6	2.4	5.7
May	54.1	7.4	52.9	9.3
June	49.8	13.4	61.2	14.8
July	26.5	17.1	37.3	17.3
Total	137.1		153.8	

Table 2. Grazing Periods for Study Pastures During the 2004 and 2005 Grazing Season at Lanigan, Saskatchewan.

Paddock/Year	Start Date	End Date	# of Days
2004			
CWG Goliath (rep1) [zy]	June 22	July 14	22
CWG Goliath (rep2)	June 22	July 14	22
HBG(1999) (rep1)	June 15	July 14	29
HBG(1999) (rep2)	June 15	July 14	29
HBG(2003) (rep1)	June 22	July 14	22
HBG(2003) (rep2)	June 22	July 14	22
SBG (rep1)	June 15	July 14	29
SBG (rep2)	June 15	July 14	29
MBG (rep1)	June 15	July 14	29
MBG (rep2)	June 15	July 14	29
2005			
CWG Control (rep1)	May 27	June 9	13
CWG Control (rep2)	May 27	June 9	13
CWG Goliath (rep1)	May 27	July 7	41
CWG Goliath (rep2)	May 27	June 30	34
HBG(1999) (rep1)	June 7	July 12	35
HBG(1999) (rep2)	June 7	July 12	35
HBG(2003) (rep1)	June 6	July 7	31
HBG(2003) (rep2)	June 6	July 14	38
SBG (rep1)	June 7	July 12	35
SBG (rep2)	June 7	July 12	35
MBG (rep1)	June 7	July 12	35
MBG (rep2)	June 7	July 12	35
TF (rep1)	June 10	July 14	34
TF (rep2)	June 10	July 14	34

[z]CWG Control = crested wheatgrass control; CWG Goliath = crested wheatgrass 'Goliath'; HBG(1999) = hybrid bromegrass seeded in 1999; HBG(2003) = hybrid bromegrass seeded in 2003; SBG = smooth bromegrass; MBG = meadow bromegrass; TF = tall fescue.
[y]rep1 = replicate 1; rep2 = replicate 2.

Cumulative Dry Matter Yield

Cumulative dry matter yield was analyzed separately for 2004 and 2005 due to a significant year x species interaction ($p<0.05$) (Table 3). With the exception of CWG cv. 'Goliath', all varieties tended to yield higher in 2004, which may be due to the distribution of rainfall prior to and during the grazing period. In 2004, there were no significant differences in CDMY between varieties ($p>0.05$) despite the numerical differences. In 2005, CWG cv. 'Goliath' yielded significantly greater than the remaining pasture types ($p<0.05$). Crested wheatgrass has been recommended for early spring grazing because of its early spring growth (Vogel et al. 1993). This species is better able to utilize early spring moisture and cooler temperatures in April, May

and June (Table 1) for optimal growth compared to mid-season type species such as the bromegrasses and tall fescue. Dry matter yield of CWG control pastures is similar to those reported by Thompson (2003).

Previous research has indicated that SBG performs well in a one-cut system while MBG and HBG perform well in multi-cut systems (Knowles 1987; Coulman 2004). In both 2004 and 2005, only one grazing period occurred and this may explain why no differences were observed in CDMY between these bromegrass species. An additional grazing period may have shown MBG and HBG to yield higher than SBG due to their greater regrowth potential.

Tall fescue yielded similar to all bromegrass species in 2005. There is a lack of CDMY data available for TF in the Dark Brown/Black soil zone of Saskatchewan. However, in the United States, TF has yielded 1961to 2813 kg ha^{-1} in north-west Georgia (Hoveland et al. 1991) and 7007 to 8475 kg ha^{-1} in Missouri (Wen et al. 2002) demonstrating that there is a wide range of forage production dependent upon location and climate.

Table 3. Cumulative Dry Matter Yield of Six Pasture Types under Grazed Conditions at Lanigan, Saskatchewan.

	CWG Control[z]	CWG Goliath	HBG (1999)	HBG (2003)	SBG	MBG	TF	SEM[y]
Cumulative dry matter yield (kg ha^{-1})								
2004	-	4484	9228	8967	7499	7333	-	739.16
2005	2484*a*	7514*b*	4533*a*	3136*a*	3197*a*	2868*a*	3932*a*	486.90

[z]CWG Control = crested wheatgrass control; CWG Goliath = crested wheatgrass cv. 'Goliath'; HBG(1999) = hybrid bromegrass seeded in 1999; HBG(2003) = hybrid bromegrass seeded in 2003; SBG = smooth bromegrass; MBG = meadow bromegrass; TF = tall fescue.
[y]SEM = standard error of the mean.
a-b Means in the same row with different letters are different ($P<0.05$).

Steer Performance

Average daily gain, AGD and TBP data were pooled for both years due to no significant year x variety interaction ($P>0.05$). Steers grazing the CWG control pastures had significantly greater ($p<0.05$) ADG than animal on the HBG plots seeded in 2003 (Table 4). Steer performance was expected to be high for CWG pastures as this species is known for very high forage quality in the spring (Hart et al. 1983a). Performance of grazing animals is dependent upon a number of factors, including forage quality and intake, with forage intake being partially dependent upon forage quality (Hart et al. 1983a). Therefore, grazing CWG in the spring when forage quality is greatest (and forage intake is high) should result in good animal performance as shown by this study. Table 5 shows previously published steer performance for species included in the current study. These results tend to be similar to the ones observed in the present study. A short grazing period, high forage quality and potential compensatory growth of the tester animals may have attributed to the high daily gains observed on crested wheatgrass.

Table 4. Steer Performance Grazing Six Pasture Types in 2004 and 2005 at Lanigan, Saskatchewan.

	CWG Control[z]	CWG Goliath	HBG (1999)	HBG (2003)	SBG	MBG	TF	SEM[y]
Average daily gain (kg d^{-1})								
2004	-	1.40	1.30	1.30	1.17	1.37	-	0.05
2005	1.60*a*	1.51*ab*	1.46*ab*	0.80*b*	1.19*ab*	1.19*ab*	1.39*ab*	0.09
Mean	1.60*a*	1.45*ab*	1.38*ab*	1.05*b*	1.18*ab*	1.28*ab*	1.39*ab*	0.05
Animal grazing days (d ha^{-1})								
2004	-	124*b*	163*a*	124*b*	163*a*	163*a*	-	6.4
2005	78*b*	230*a*	252*a*	232*a*	221*a*	235*a*	229*a*	15.9
Mean	78*c*	176*b*	208*ab*	178*b*	192*b*	199*ab*	229*a*	11.51
Total beef production (kg ha^{-1})								
2004	-	174*ab*	212*ab*	162*b*	190*ab*	224*ab*	-	9.4
2005	125*b*	349*a*	309*ab*	189*ab*	271*ab*	281*ab*	317*ab*	26.2
Mean	124.5*c*	261.3*ab*	260.5*ab*	175.0*bc*	230.3*abc*	252.5*ab*	316.5*a*	17.13

[z]CWG Control = crested wheatgrass control; CWG Goliath = crested wheatgrass 'Goliath'; HBG(1999) = hybrid bromegrass seeded in 1999; HBG(2003) = hybrid bromegrass seeded in 2003; SBG = smooth bromegrass; MBG = meadow bromegrass; TF = tall fescue.
[y]SEM = standard error of the mean.
a-c Means in the same row with different letters are different (P<0.05).

Tall fescue, MBG and HBG had the greatest number of AGD, followed by SBG, CWG cv. 'Goliath' and finally the CWG control pasture ($p<0.05$). High AGD for TF, MBG and HBG may result from the growth habit of these species. Tall fescue is a bunch to sod-type grass with good regrowth potential when grazed (Balasko and Nelson 2003) and has the ability to provide more AGD per year than any other tall-growing, cool-season grass (Smith et al. 1986). Tall fescue is adapted to warm, humid areas of the world (Moore 2003) and was likely better able to utilize warm temperatures and rainfall in June and July compared to other species. Meadow bromegrass and HBG have also shown excellent regrowth potential compared to SBG as they can elongate previously defoliated tillers and SBG cannot (Coulman and Knowles 1995). Meadow bromegrass, HBG, SBG showed similar CDMY, however it is possible that some regrowth of MBG and HBG occurred later in the grazing period and contributed to total CDMY while SBG initially yielded higher and lacked regrowth during the grazing period, leading to similar AGD among these bromegrass species. Crested wheatgrass control pastures showed the least AGD ($p<0.05$) which is reflected by the low CDMY shown for this variety. Low available forage for grazing resulted in a very short grazing season in 2005. Theses results are very similar to the AGD on control CWG plots published by Thompson (2003) at a similar site in Saskatchewan.

Total beef production is a saleable product resulting from the combination of ADG and AGD. Therefore, it is not surprising that even though the CWG control pasture had the highest ADG, it showed the lowest TBP because of the limited number of animal grazing days. The control

pastures yielded significantly lower ($p<0.05$) TBP in comparison to all other pasture types, with the exception of SBG and HBG seeded in 2003. Numerically, TF had the highest TBP but was not significantly greater than CWG cv. 'Goliath', HBG (1999), SBG or meadow bromegrass. High TBP for these species indicate their ability to provide good animal performance under grazed conditions. The results of this study show higher TBP than that previously reported by Thompson (2003). Total beef production was 101 to 117 kg ha^{-1} for CWG, 117 to 153 kg ha^{-1} for SBG, 134 to 143 kg ha^{-1} for MBG and 183 to 185 kg beef ha^{-1} for hybrid bromegrass (Thompson 2003). Steer performance grazing TF in this trial is comparable to the 287 kg ha^{-1} reported by Hoveland et al. (1997) and 264 to 354 kg ha^{-1} reported by Wen et al. (2002). Steer gains on TF from this study look promising; however, these results are based on only one grazing season. Several years of data may be needed to accurately represent the long-term performance of TF in the thin Black soil zone of Saskatchewan. Tall fescue in this study is newly established and stand persistence of this species for east-central Saskatchewan has not yet been determined at this time.

Table 5. Steer Performance for Spring and Summer Grazed Pastures Types.

Species	Average daily gain (kg d^{-1})	Reference
Crested wheatgrass	0.71-1.17	Hart et al. 1983b
	0.79	Hofmann et al. 1993
	0.89-0.96	Karn et al. 1999
	1.03-1.57	Thompson 2003
Smooth bromegrass	0.86	Hofmann et al. 1993
	0.53-1.24	Thompson 2003
Meadow bromegrass	0.72-0.86	Knowles et al. 1993
	0.78-1.36	Thompson 2003
Hybrid bromegrass	0.74-1.62	Thompson 2003
Tall fescue	0.76-1.03	Hoveland et al. 1991
	1.03	Hoveland et al. 1997
	0.65-0.73	Wen et al. 2002

Conclusions

Newer forage varieties have the potential to show greater forage and animal performance compared to older varieties. High forage yields and steer performance from CWG cv. 'Goliath' corresponds to high moisture availability and may allow this variety to work well in a complementary grazing system. As previous research indicates, there were very few production differences observed among the three bromegrass species. A second grazing period in each year of the trial, may have shown production differences based on the regrowth potential of these species. In year two of study, TF cv. 'Courtney' has shown to provide similar forage and animal performance data to CWG cv. 'Goliath' and the bromegrass species. With further grazing

research, TF may prove to be another variety beef producers can confidently use in their grazing systems. Finally, the results of this study shows significant variation among years and varieties for plant and animal data, and more long-term data is needed to provide more conclusive results.

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